



X-33 XRS-2200 Linear Aerospike Engine Sea Level Plume Radiation

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Presented at:

NASAMSFC Fluids Workshop

April 5, 2001



Introduction & Objectives

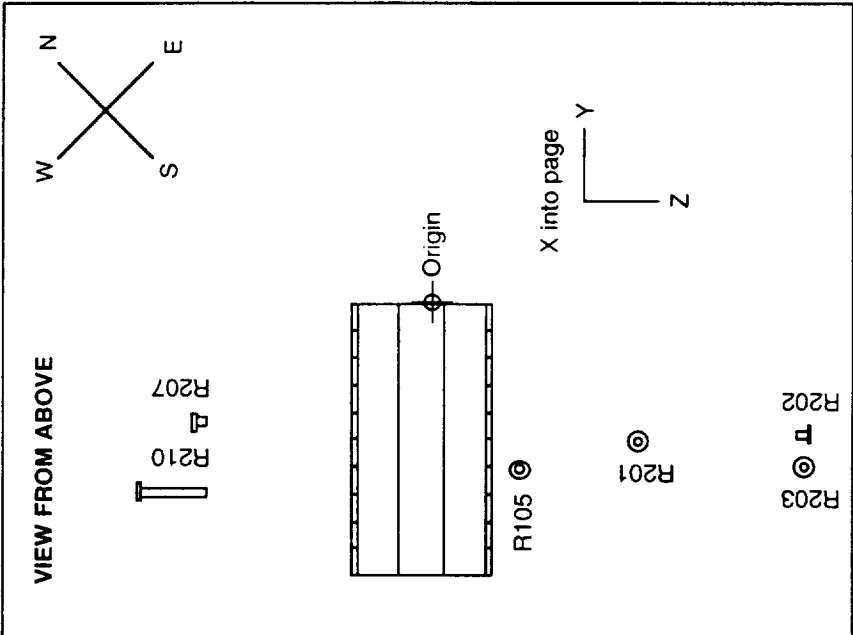
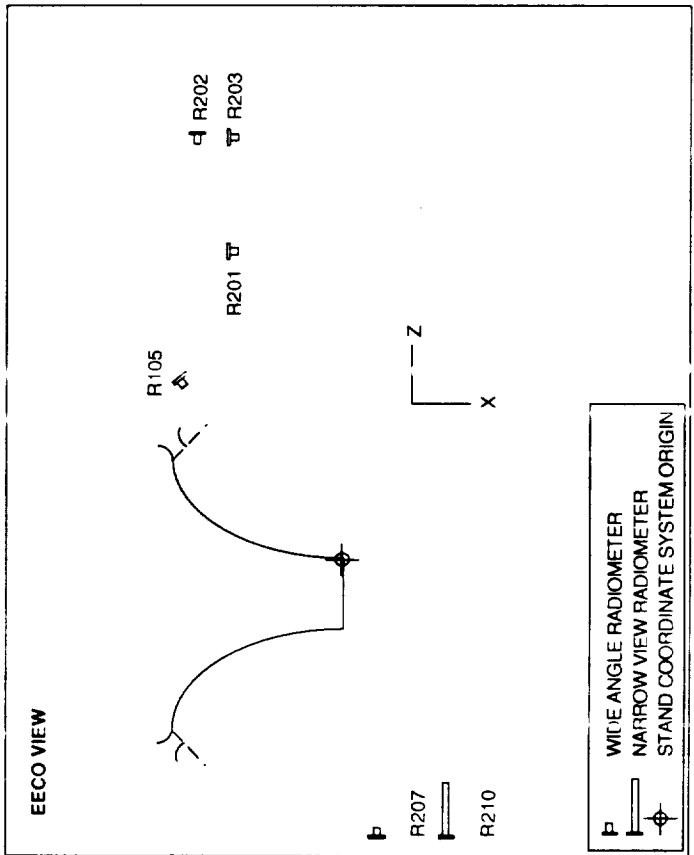


- XRS-2200 Was The Planned X-33 Engine
 - Linear Aerospike
 - Liquid Hydrogen / Liquid Oxygen Fuel
 - Gas Generator Cycle
 - 207,000 lbf Thrust at Sea Level
- Non-Traditional Design Raised Uncertainty In Base Heating Environment Predictions
- Collected Wide Band Infrared Plume Radiation Data To Validate X-33 Vehicle Plume Induced Base Heating Environments
- Planning Began in 1998, Tests Conducted In 1999 & 2000

Test Setup

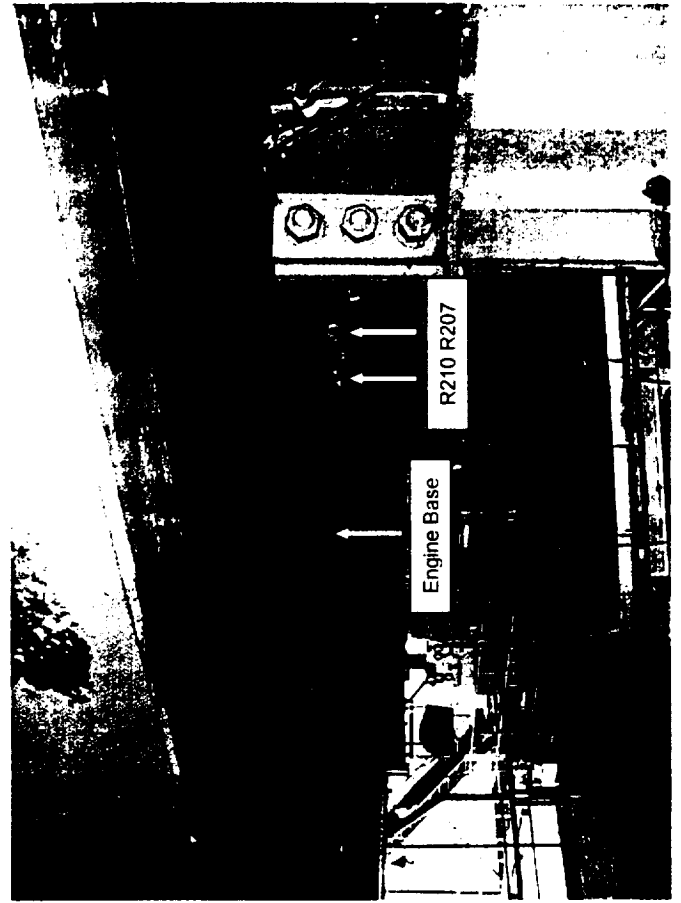
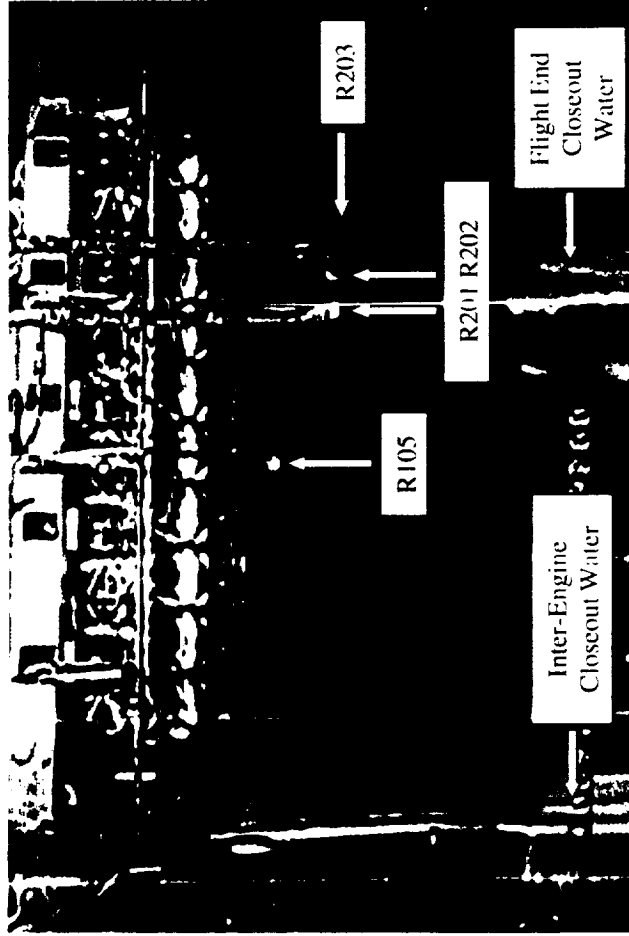


- 6 Primary Radiometers
 - 5 Hemispherical 180° Field of View (FOV)
 - 1 Narrow View 4° FOV
 - Medtherm Schmidt-Boelter Type





Test Setup (con't)





Test Conditions

The NASA logo, consisting of the word "NASA" in white, bold, sans-serif capital letters inside a black circle.

- 10 Sea Level Tests of a Single X-33 XRS-2200 Engine at the NASA Stennis Space Center Test Stand A1 in 1999 and 2000
- Test Conditions Varied From 100% to 57% Power Level and 6.0 to 4.5 Oxidizer to Fuel Ratio

Results

Cooling Water Attenuation

- Most Data From First Five Tests Had to Be Discarded Due to Attenuation by Engine End Closeout Cooling Water

Tests 21-23



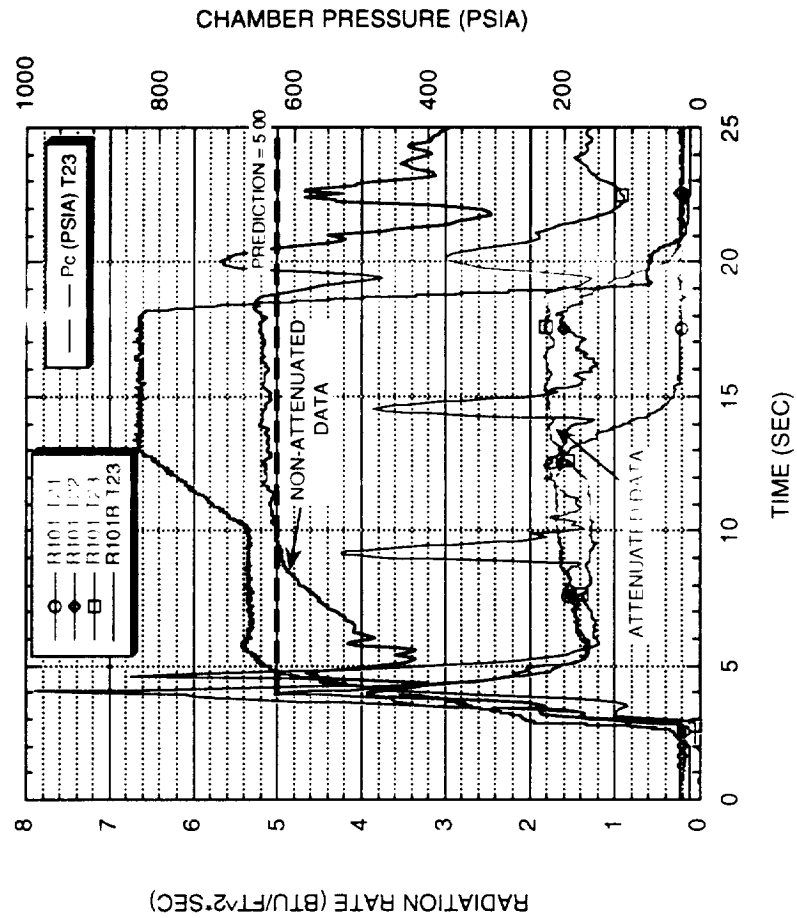
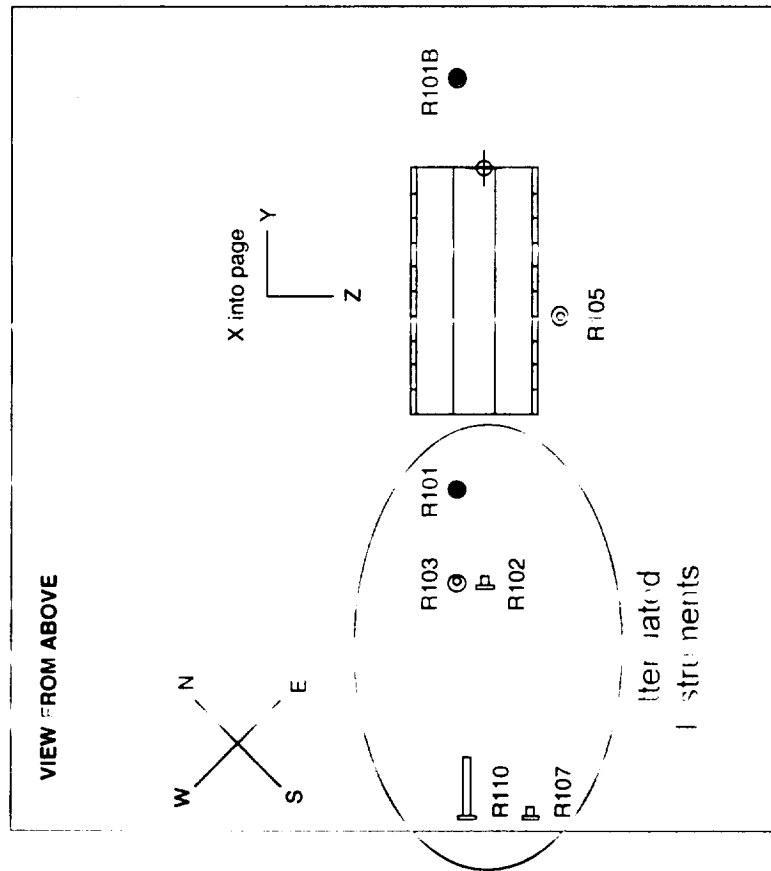
Tests 24-31





Results (con't)

- Comparison of Results From Ends With and Without End Closeout Cooling Water Shows Attenuation Effect

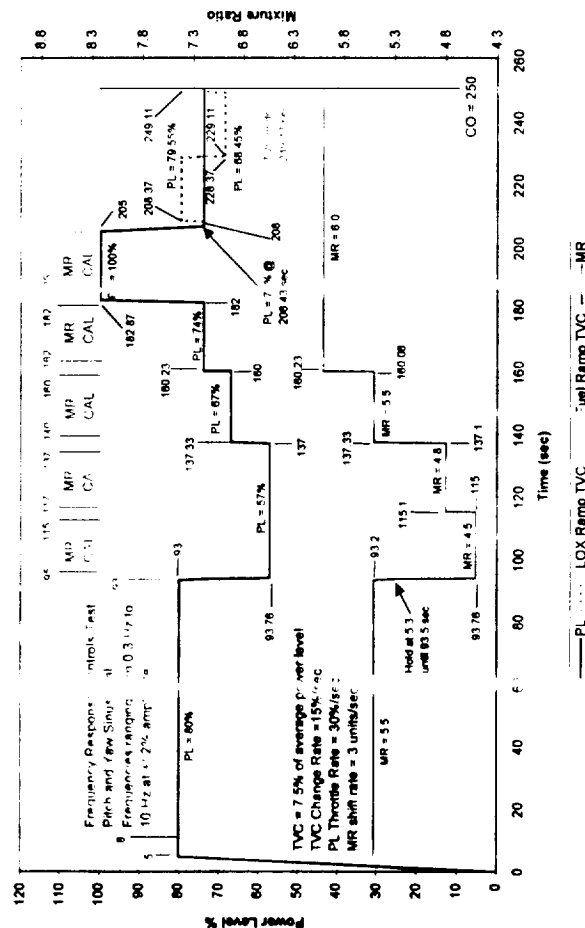




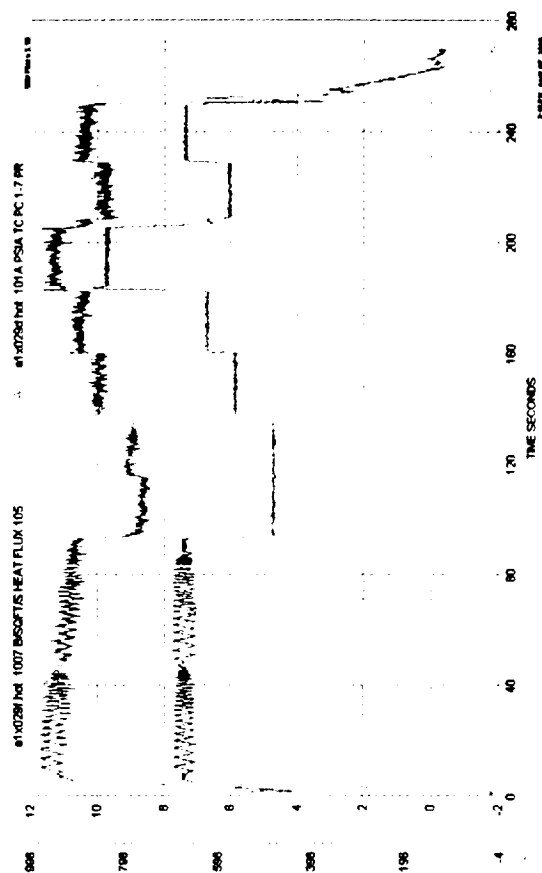
- Radiation Data Tracked Test Conditions Well

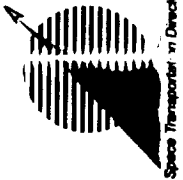
Power Level and Mixture Ratio Vs. Time

Proposed ProfileTest A1X029



R105 Radiation and Chamber Pressure Vs. Time





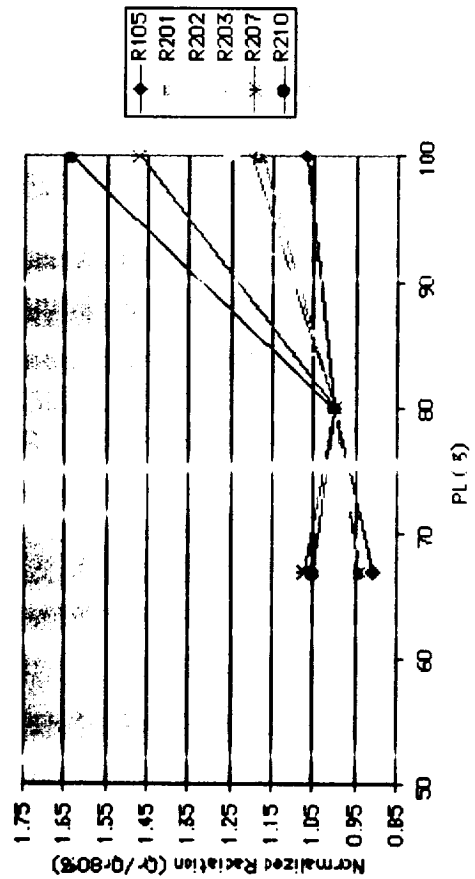
Results (con't)

NASA

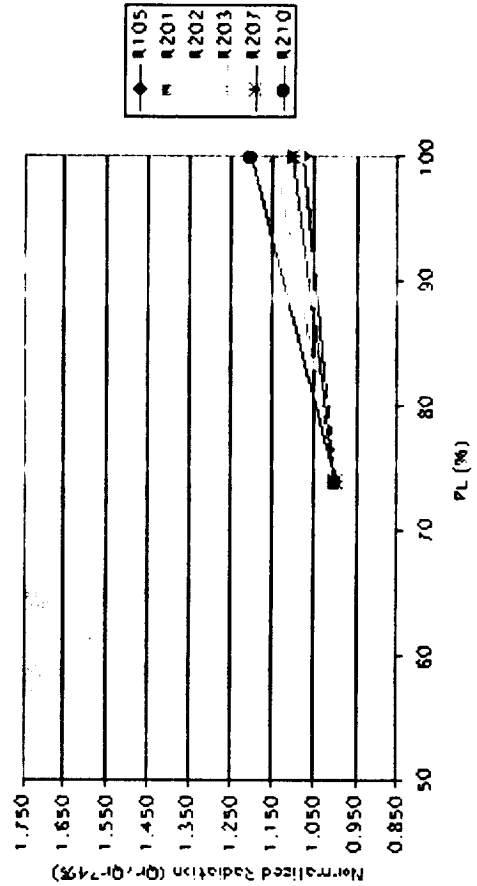
General Trends

- Measured Radiation Rates Generally Increased With Engine
 - Chamber Pressure
 - Mixture Ratio
- Base Instruments Show Some Evidence of Higher Localized Heating at Lower Power Levels

Tests 25, 27, 29 O/F=5.5



Test 29, O/F=6.0



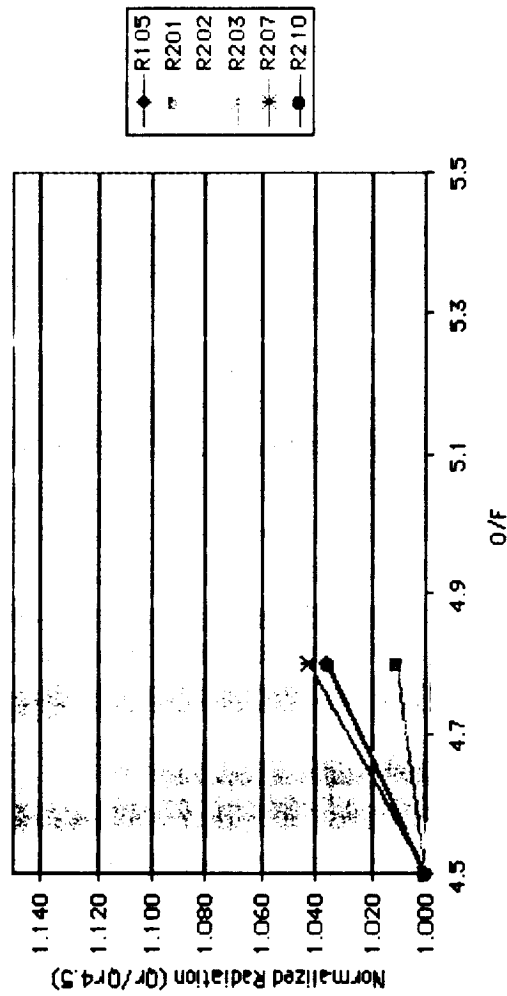


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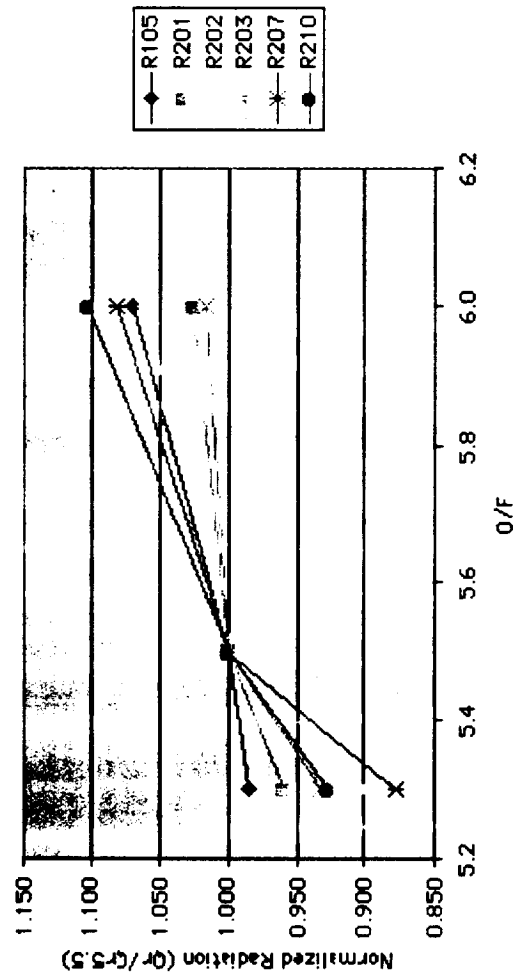
Results (con't)



Test 29, 57% Power Level



Test 31, 100% Power level



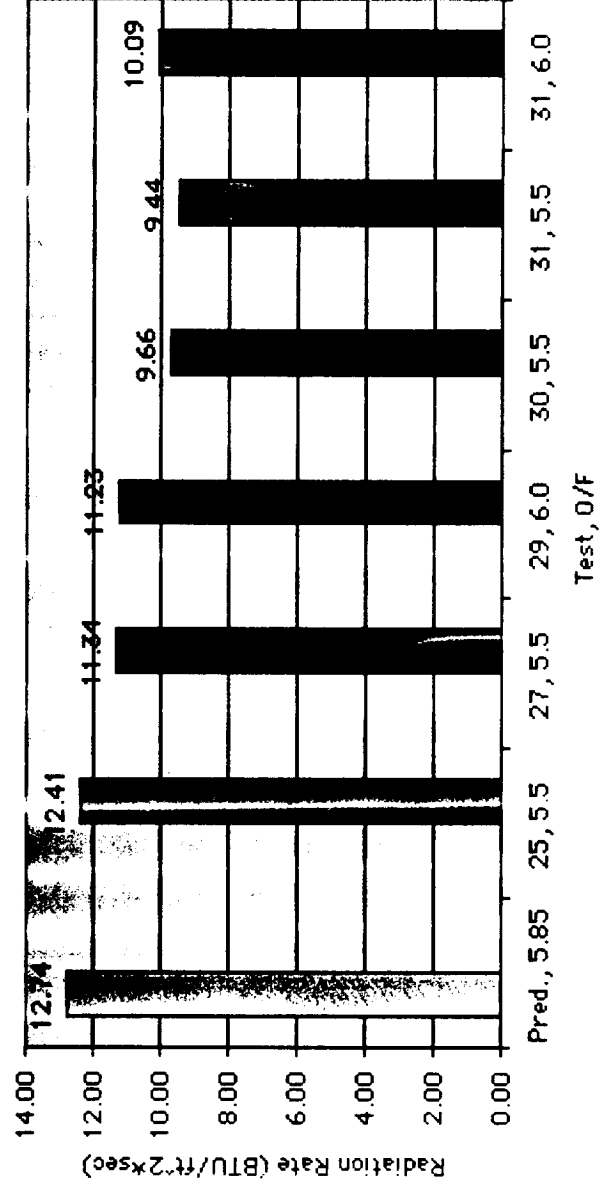


Comparison With Predictions

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- FDNS Code Used To Generate 100% Power Level, $M_{\infty} = 0$ Plume Flow Field (T.S. Wang)
- Radiation Predicted With GASRAD Band Model Code (Young Lee)
- Predicted Levels Ranged From 39% Over to 7% Under Average Test Values

R105 COMPARISON, 100% PL



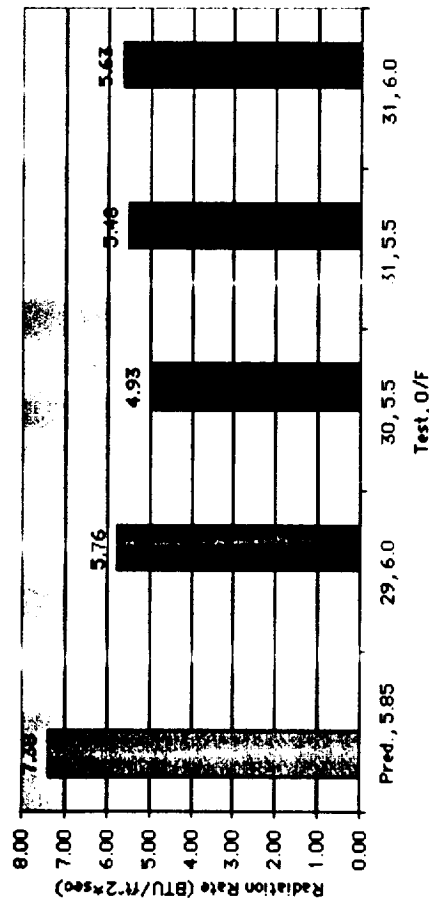


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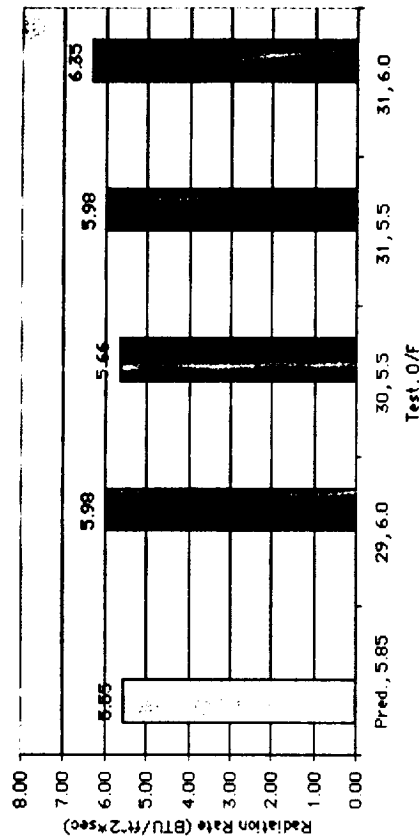
Comparison With Predictions (con't)



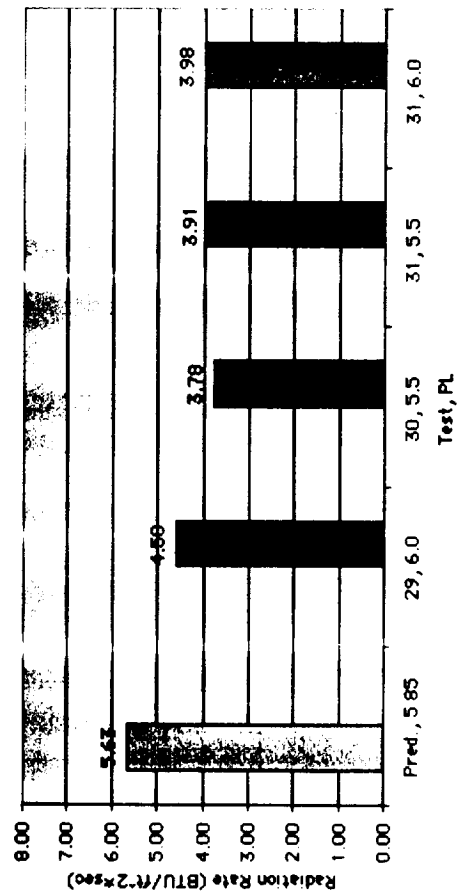
R201 COMPARISON, 100% PL



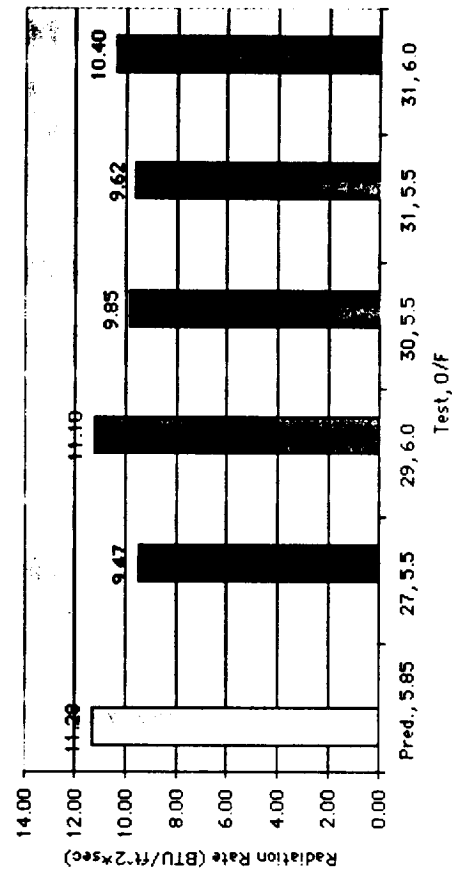
R202 COMPARISON, 100% PL



R203 COMPARISON, 100% PL



R207 COMPARISON, 100% PL





Conclusions

NA SA

- Full Set of Linear Aerospike Plume Radiation Data Collected
- Challenges Met and Overcome
- Good Agreement With Predictions
 - Mixture of CFD and Traditional Engineering Codes Applied To Non-Traditional Configuration